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Final Report for IUE NASA Grant NAG5-1421

A Search for Damped Lyα Absorption Lines from Low-Redshift Galaxies

A NASA Astrophysics Data Program

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The purpose of this IUE archival data program was to perform a systematic, unbiased survey for low-redshift ($0.1<z<1.6$) galactic or proto-galactic HI disks. The survey was performed using all available IUE archival spectra of QSOs and AGN which have sufficient quality to identify the characteristicly strong damped Lyα absorption lines that must arise in their spectra when lower redshift galaxies or proto-galaxies with column densities N(HI) $> 2(10^{20})$ cm^{-2} lie in front of them. By combining results from the IUE data which cover the redshift range $0.1<z<1.6$ with those from optical surveys which cover the redshift range $1.6<z<3.5$, we are able to search for evolution of the damped Lyα absorbers with redshift and identify a sample of low-redshift damped Lyα absorbers. The results constrain theories of galaxy formation and provide examples for later follow-up studies which will allow investigators to empirically determine the type or types of galaxies responsible for damped Lyα absorption.

The program had three phase: (1) a feasibility study, (2) optimal processing of all relevant IUE archival spectra, and (3) analysis and interpretation of the results. In our 1990/91 ADP work beginning in May 1990, we demonstrated feasibility. This resulted in a two year ADP award for 1991/92 and 1992/93 which enabled us to proceed to phases (2) and (3) noted above. The publication entitled *Ultraviolet Spectra of QSOs, BL Lac Objects, and Seyfert Galaxies* by K. M. Lanzetta, D. A. Turnshek, and J. Sandoval (1993, ApJS, 84, 109–184), along with the formation of an optimal IUE database for subsequent analysis, ended phase (2). Phase (3) will result in at least two more publications. One paper entitled *Damped Lyα Absorption in Q0957+561A,B* by D. A. Turnshek and R. C. Bohlin (1993, ApJ, 407, 60–64) has already been published, while another has been submitted. Additional papers which use the results of this work may be submitted for publication, but they will primarily be interpretive and base on the analysis presented in the paper which was recently submitted. Included are the reprints of the two papers that have been published. In addition, we summarize below the results of the paper recently submitted.

Based on a sample of optimally extracted and coadded IUE spectra of QSOs, BL Lac objects, and Seyfert galaxies, we present a spectroscopic survey for moderate-redshift absorption features from damped Lyα and Lyman-limit absorption systems. Results of this survey are combined with those of previous surveys carried out at optical wavelengths in order to examine the evolution of the gaseous content of the Universe over the redshift interval $0.008 < z < 3.5$. The main results are that (a) the product of the absorption cross section and the comoving spatial number density of damped Lyα absorption systems does not appear to evolve strongly over the redshift interval $0.008 < z < 3.5$, (b) the cosmological mass density $\Omega_g(z)$ of neutral gas associated with damped Lyα absorption systems appears to decrease significantly from $z = 3.5$ to 0.008, and (c) this evolution of the cosmological mass density $\Omega_g(z)$ of neutral gas associated with damped Lyα absorption systems results from a steady decrease in the incidence of high column density absorption systems with decreasing redshift.

Together these results suggest that the average mass of neutral gas per absorption system decreases with time, which is qualitatively consistent with the hypothesis that the observed evolution of $\Omega_g(z)$ results from the consumption of gas into stars at $z < 3.5$. We present additional arguments supporting this hypothesis and assess the implications of the observations of $\Omega_g(z)$ for scenarios of galaxy formation and evolution.